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T4 - RESISTANCE THERMOMETERS FOR FLUES

Resistance thermometers of this group are specifically designed for use at increased temperatures, e.g. in flues for temperatures up to 700°C.
Electrical connection is made via a terminal block or a transmitter in the connection head.
Basic parts of thermoelement are as follows:
- connection head,
- external protection tube,
- measuring insert with resistance sensor,
- process connection.

Connection head of the resistance thermometer can be of various dimensions and shapes and is defined via the configurator.

External protection tube of the resistance thermometer is made of material selected to suit the process conditions. Protection tube can be enameled or non-enameled and is directly immersed in the medium in which the temperature is measured.

Measuring insert can be in classic and mantel design with different types of resistance sensor that are defined via the configurator.

We recommend the mantel design, which has a number of advantages:
- the junction of the sensor and the lines is in highly compressed magnesium oxide without the presence of oxygen,
- faster response,
- great resistance to vibrations,
- higher reliability in operation,
- longer service life.

The only advantage of the classic measuring insert is the lower price.

Process connection is achieved using:
- flange, according to DIN 43734,
- movable connection (compression fitting)

Flange and movable connection (compression fitting) can be moved along the longitudinal axis of thermoelement, which regulates the installation length.

Technical characteristics

Basic technical characteristics are specified in the configurator.
By filling in the configurator, an order code is generated, which defines the product.

Use
- flues.

Field of use

Group T4 resistance thermometers with external metal or metal enameled tubes are suitable for use in flues for temperatures < 700°C.

The main advantage of these resistance thermometers is their lifetime, which makes them suitable for use in a wide variety of flues, at increased temperatures, vibrations and in the presence of abrasion.

The installation of resistance thermometer is given in Figure 1.

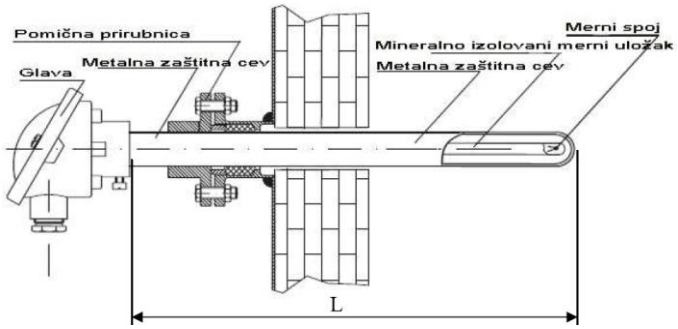


Figure 1. *Installation of* ***Group T4*** *resistance thermometer (*Movable flange/Metal protection tube/Head, Measuring junction/Mineral insulated measuring insert/Metal protection tube*)*

Functionality and structure:

Measurement principle

The Pt 100 resistance sensor has an electrical resistance of 100Ω to 0°C. It is commonly known as a Pt sensor in accordance with the IEC 751 standard. This resistance value increases with temperature, which is related to the characteristics of the resistor material (platinum). These types of sensors are called elements of positive temperature coefficient (PTC). The coefficient is fixed at α=0.00385, calculated between 0°C and 100°C, according to ITS90 (International Temperature Scale of 1990).

Two types of platinum resistance thermometers are generally used:

- **with wire wound (WW)** which consists of a thin wire of high-purity platinum, double-wound inside a ceramic case. The ends of the case are closed with ceramic mass. The measurements obtained with these resistance thermometers are not only repeatable, but also show long-term thermal resistance / stability of the temperature characteristic in the

temperature measurement range up to 600°C. This type of sensor is relatively large in size and is not resistant to vibrations.

- **thin-filmed platinum resistance thermometers (TF)** consisting of a precise amount of platinum deposited, in a thickness of 1μ, by evaporation under vacuum, on a ceramic substrate. The platinum film is then structured to form a resistance trace, using either a lithographic process or a laser beam, and then calibrated with a laser. Then a layer of glass with a thickness of 10 to 15 μ is placed to protect the platinum. The connection wires are welded, in order to establish an electrical connection with the resistance trace and to secure the shell.

Common characteristics for all thin-filmed sensors are fast response, low thermal mass, i.e. smaller dimensions and significantly increased resistance to vibrations. Temperature changes in the resistance of such a sensor cause the desired temperature that is relevant to the change in resistance. The resistance characteristic at higher temperatures differs from that of standard, (WW) resistance sensors, so these resistors are used to measure temperatures up to 500°C.

Constituent parts

The structure of the **Group T4** resistance thermometer is modular (detachable). The basic parts of the resistance thermometer are the measuring insert, protection tube, connection head in which the transmitter or ceramic block can be placed, for electrical connection.

Structure and production of **Group T4** resistance thermometers is based on the following standards: DIN 43729 (connection head); DIN 43772 (protection tubes); DIN 43762 (measuring inserts). The use of these standards guarantees the quality of manufactured thermometers and a very long service life in both simple and complex industrial processes.

Measuring insert-mantel structure (replaceable) is placed inside the protection tube and its position can be fixed using the springs on the ceramic block so that the top of the measuring insert touches the bottom of the protection tube, which ensures good heat transfer. The Pt 100 sensor is placed in the measuring insert directly to the top of the measuring insert.

The layout of the measuring insert is given in Figure 2.

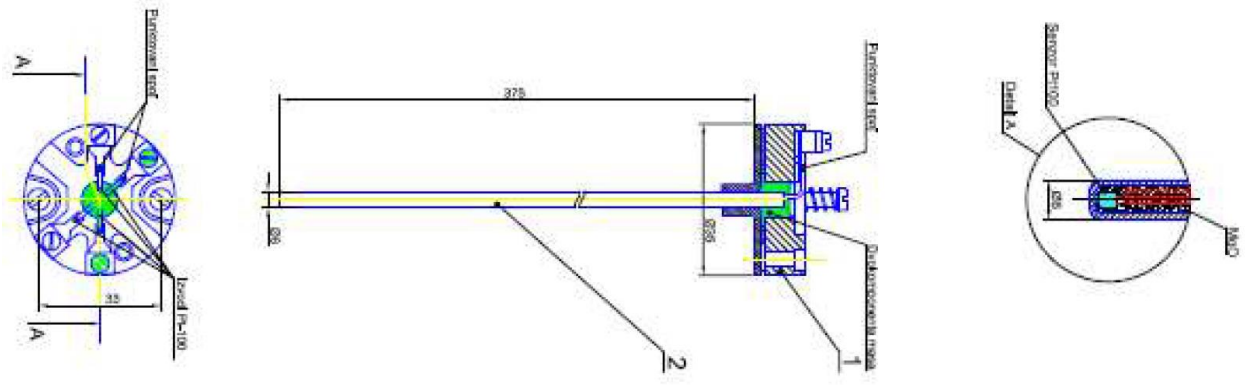


Figure 2 – Measuring insert with ceramic block

1- Ceramic block with contacts for puncturing the mantle outlet
2- Measuring insert – mantel structure

Protection tubes

With **Group T4** resistance thermometers, metal tubes and metal-enameled tubes are used as external protection tubes.

Depending on the temperature and more or less on the severity of the working conditions in which they are used, metal protection tubes are produced from different steels and special alloys, as given in Table 1.

Table 1: *Standard materials and diameters of protection tubes*

External protection tube Material	Diameter [mm]	Max temp. [°C]	Characteristics / Use
Č.1214; W.Nr. 1.0305, St. 35.8	15	550	Resistant to water in closed systems, neutral gases, flue gases.
Č.1214; W.Nr. 1.0305, St.35.8	15	700	Resistant to water and steam, hot acids and vapors, liquefied gas, sulfur vapors and gases, molten lead, tin and zinc, alkaline environments, gasoline, flue gases

Use of protection tubes made of the said steels depends a lot on the type and composition of flue gases (sulfur concentration - primarily), the presence of currents, vibrations, abrasion, etc.The tips of the protection tubes that are in the working medium are welded with special technology and guarantee optimal mechanical resistance and ensure effective temperature measurement, i.e. fast response.

Connection head

Group T4 resistance thermometers use connection heads, shape B, according to DIN 43729, connection head KNH-L, in which a transmitter and a ceramic block or two transmitters can be installed, and many other connection heads of different shapes and materials. The connection heads are given in Figure 3.

Length

All **Group T4** resistance thermometers can be ordered in the lengths specified in the Ordering information. Lengths 500, 710, 1000, 1400 and 2000mm are considered standard. Thermoelements of non-standard lengths can be ordered depending on the specification and technical characteristics of the process.

Electronics

If the customer wants a current output signal, a 2-wire transmitter is installed in the connection head. Transmitters in 2-wire technology and with an output signal of 4-20 mA are very easily programmed with the help of a personal computer, a programming unit and the appropriate software. Transmitters are galvanically isolated. If the transmitter is intended for installation on a DIN rail, then a ceramic block with terminals for electrical connection is installed in the connection head.

Performances

Working conditions for the connection head

Ambient temperature - the case when the connection head is without transmitter: - 40 to 130°C.
Ambient temperature - the case when the transmitter is installed in the connection head: - 40 to 85°C.

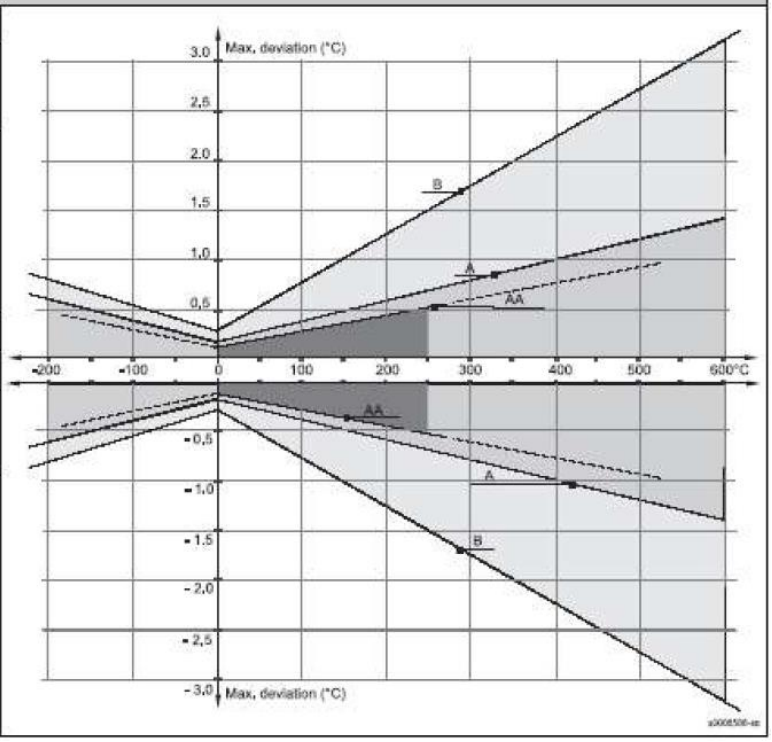
Process temperature

Operating range is defined - determined based on the combination of the type of thermocouple and the material of the protection tube.

Accuracy (certainty)

Given in Figure 3.
Sensor Pt 100 according to IEC 751.

Class	max. Tolerances (°C)	Temperature range	Characteristics
RTD max. error type TF - range: -50 to +400 °C			
Cl. A	± (0.15 + 0.002 · |t|[1])	-50 °C to +250 °C	
Cl. AA, former 1/3 Cl. B	± (0.1 + 0.0017 · |t|[1])	0 °C to +150 °C	
Cl. B	± (0.3 + 0.005 · |t|[1])	-50 °C to +400 °C	
RTD max. error type WW - range: -200 to +600 °C			
Cl. A	± (0.15 + 0.002 · |t|[1])	-200 °C to +600 °C	
Cl. AA, former 1/3 Cl. B	± (0.1 + 0.0017 · |t|[1])	0 °C to +250 °C	
Cl. B	± (0.3 + 0.005 · |t|[1])	-200 °C to +600 °C	



|t| - absolute value in °C.

Figure 3. *Accuracy classes of Pt sensors****Response time***

Response time for these types of resistance thermometers is not a circular parameter.
If you want that information, contact the Technical Service - TERMOTEHNA.

Insulation
Insulation resistance is ≥100MΩ at room temperature.
The insulation resistance between each terminal and the sheath is checked at a voltage of 100 V DC.

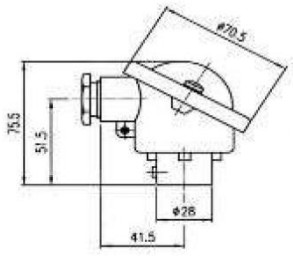
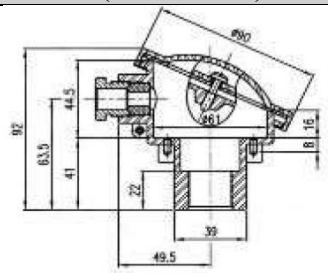
Self-heating
In order to measure the output signal of a resistance thermometer, current must pass through the sensor. This measuring current generates a power loss and thus produces heat on the sensor. As a result, the measured temperature is higher than it should be. This self-heating depends on several factors, and one of them is how far the generated power drop can be taken through the measuring device. Self-heating creates additional measurement error. This error is negligible if a transmitter is built into the resistance thermometer.

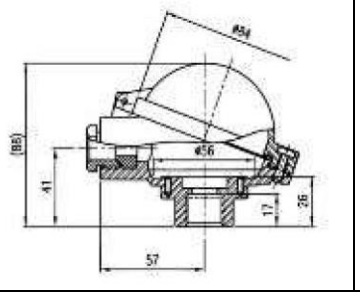
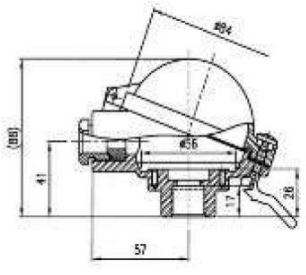
Installation
Given in Figure 1. It is possible to replace the measuring insert during operation, without stopping the process.

Components

Connection head
Pursuant to the provisions of the DIN 43729 standard, the housing of the connection head, shape B, contains a ceramic block with electrical terminals or a transmitter. It can be of different types and materials (e.g. painted aluminum, crude iron or stainless steel).
It is possible to simultaneously install a ceramic block and a transmitter or two transmitters in the housing of the connection head, shape KNH-L.

Connection heads are given in Figure 4.

head B (DIN 43729)		head A (DIN 43729)	
			

head BA-KL	Ex	head BSS	
			

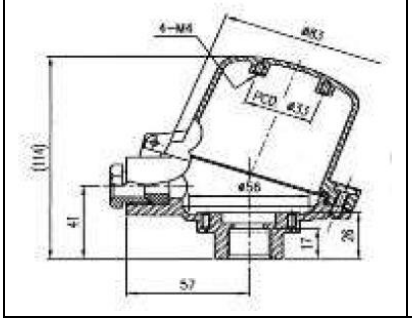
head KNH-L	
	

Figure 4*. Connection heads*

Transmitters

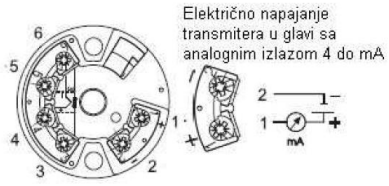
The following transmitters are applicable:

- PC programmable transmitters 4...20mA (galvanically isolated)
- Transmitters with HART protocol (galvanically isolated), the output contains 4...20mA and HART superimposed signals
- Transmitters (galvanically isolated) PROFIBUS PA with output signal, the communication address can be set via the appropriate software or by means of mechanical switches. Customer can request the desired configuration during the ordering process.

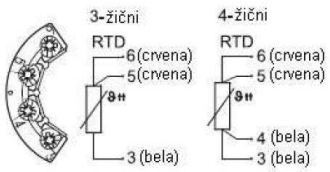
If the transmitters are installed on a DIN rail, ceramic blocks are installed in the connection head.

Wiring

Method of connecting the sensor to the transmitter - Figure 5; to a ceramic tile - Picture 6.



Power supply of the transmitter in the head with analog output 4 to mA



3-wire
6(red)/ 5 (red)/ 3 (white)
4-wire
6(red)/ 5 (red)/4 (white)/ 3 (white)

Figure 5. *Transmitter installed in the connection head - connection diagram*

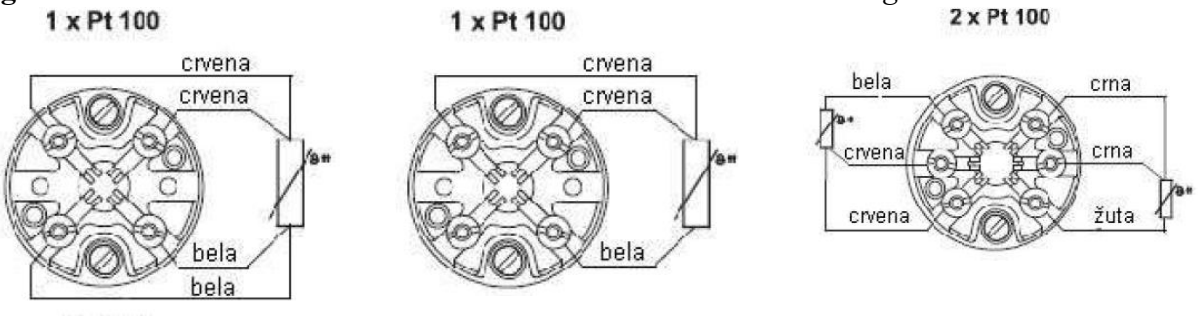


Figure 6. *Ceramic block installed in the connection head - connection diagram*

Auxiliary equipment

Movable flange
For A= 15[mm]
B= 55[mm]; C= 75[mm]

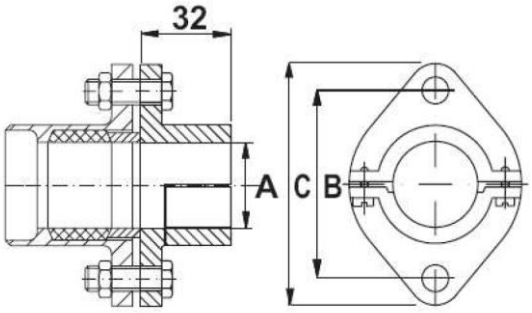


***Figure 6**. Movable flange according to DIN 43734*

Certificates

- Calibration certificate for temperature measuring instruments
- Calibration certificate for temperature measuring equipment
- Certificate of calibration laboratory accreditation - accreditation no.: 02-058

Other details

Maintenance

Group T4 thermoelements do not require any special maintenance.

Periodic inspections are recommended because of mechanical damage and thermal shocks, aggressive environments, and the occurrence of abrasion can cause tube damage.

Furthermore, calibration of thermocouples is recommended, once a year, by an authorized laboratory, in line with the Law.

***Table 2**: Resistance values in [Ω] depending on temperature values*

Resistance in [Ω]										
°C	0	10	20	30	40	50	60	70	80	90
- 200	18,49	14,45	10,49	6,99	4,26	2,51	-	-	-	-
- 100	60,25	56,19	52,11	48,00	43,87	39,71	35,53	31,32	27,08	22,80
- 0	100,00	96,09	92,16	88,22	84,27	80,31	76,33	72,33	68,33	64,30
0	100,00	103,90	107,79	111,67	115,54	119,40	123,24	127,07	130,89	134,70
100	138,50	142,29	146,06	149,82	153,58	157,31	161,04	164,76	168,46	172,16
200	175,84	179,51	183,17	186,82	190,45	194,07	197,69	201,29	204,88	208,45
300	212,02	215,57	219,12	222,65	226,17	229,67	233,17	236,65	240,13	243,59
400	247,04	250,48	253,90	257,32	260,72	264,11	267,49	270,86	274,22	277,56
500	280,90	284,22	287,53	290,83	294,11	297,39	300,65	303,91	307,15	310,38
600	313,59	316,80	319,99	323,18	326,35	329,51	332,66	335,79	338,92	342,03
700	345,13	348,22	351,30	354,37	357,42	360,47	363,50	366,52	369,53	372,52
800	375,51	378,48	381,45	384,40	387,34	390,26				

Table 3: *Catalog codes for standard resistance thermometers*

Temperature	**Measuring resistance**	**Material of metal protection tube**	**Nominal length L [mm]**	**Measuring insert ∅6 Length Lu [mm]**	**Catalog number**	
					1xPt 100	**2xPt 100**
up to 400°C	Pt 100 JUS L.F2.051 in measuring insert	W.Nr. 1.0305 St. 35.8 ∅15x2	500	525	T4- 1401	T4- 2401
			710	735	T4-1402	T4-2402
			1000	1025	T4-1403	T4-2403
			1400	1425	T4-1404	T4-2404
up to 400°C	Pt 100 JUS L.F2.051 in measuring insert	W.Nr. 1.0305 St. 35.8 Enameled ∅15x2	500	525	T4-1421	T4-2421
			710	735	T4-1422	T4-2422
			1000	1025	T4-1423	T4-2423
			1400	1425	T4-1424	T4-2424
up to 500°C	Pt 100 JUS L.F2.051 in measuring insert	W.Nr. 1.0305 St. 35.8 ∅15x2	500	525	T4-1401.1	T4-2401.1
			710	735	T4-1402.1	T4-2402.1
			1000	1025	T4-1403.1	T4-2403.1
			1400	1425	T4-1404.1	T4-2404.1
up to 650°C	Pt 100 JUS L.F2.051 in measuring insert	W.Nr. 1.0305 St. 35.8 enameled ∅15x2	500	525	T4-1421.1	T4-2421.1
			710	735	T4-1422.1	T4-2422.1
			1000	1025	T4-1423.1	T4-2423.1
			1400	1425	T4-1424.1	T4-2424.1